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TECHNICAL AND ECONOMIC INDICATORS OF EXISTING AND DEVELOPED DESIGNS OF A MULTI-PURPOSE MACHINE

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Annotation: This article discusses the issues of quality indicators of a multi-purpose machine (MM-1). Also, quality indicators, production, complex economic indicators are analyzed.

***Keywords*:** economic indicators, quality indicators, multi-purpose machine, technical aesthetics.

Introduction

The system of technical and economic indicators allows you to analyze the possibilities of application and rational conditions for the use of specific models of hydraulic excavators, compare mechanization options or promising areas for the development of technology, and get recommendations on choosing the values of individual indicators for specific or typical operating conditions.

Materials, Methods and Discussion

Technical and economic indicators can be divided into: quality indicators, production, complex economic indicators.

Quality indicators include indicators of purpose, reliability, ergonomics, manufacturability, standardization and unification, technical aesthetics.

Purpose indicators characterize the operational capabilities of the machine and the progressiveness of its design. They include the main parameters, hydraulic system parameters, digging radius and height, transport speed, average pressure on the ground, the number of types of replaceable working equipment, and the duration of the working cycle [1].

The main parameters of hydraulic excavators include the mass of the machine, engine power, bucket capacity. The parameter that most fully characterizes hydraulic excavators is the mass of the machine, which determines its stability and the possibility of efficient use of a bucket of a given capacity [2].

Engine power affects the dynamic qualities and fuel efficiency. In addition, an increase in engine power leads to an increase in the transmitted torque, that is, to a greater load on the elements of the power drive, which in turn makes it necessary to increase the size of the parts [3].

The power consumed by the hydraulic drive is determined by the drive power of the pump, which is the ratio of the useful (effective) power of the hydraulic motor to the value of the total efficiency. hydraulic drive. which considers volumetric and hydro mechanical losses of the pump and hydraulic motor, as well as pressure losses in pipelines, working fluid flow control devices, including local resistances [4].

The choice of the main parameters is made in accordance with the calculation of the acting moments and forces, speeds and accelerations of the moving elements of the machine. The values of the operating parameters of the hydrostatic drive obtained by calculation are used to select a unified hydraulic equipment that is mass-produced by the industry [5].

In some cases, to evaluate individual design or operational properties of hydraulic excavators, the parameters of the main elements of the hydraulic drive system can be used: pumps, hydraulic motors, hydraulic cylinders [6].

The main parameters of these units are the performance of the pumps, the number of their revolutions and developed pressures, the force or torque of the hydraulic motor, the number of revolutions of the hydraulic motor, the volume of the hydraulic cylinders and the piston speed [7, 8, 9, 10].

The mobility of excavators is achieved by installing undercarriages (caterpillar or pneumatic wheels), increasing transport speeds, improving their movement paths, and improving maneuverability.

Transportability is ensured by the possibility of transportation by rail or in vehicles within the allowable dimensions. In the case when the equipment does not fit into the specified transport dimensions, an increase in transportability is achieved by using perfect mounting devices, ease of installation and dismantling of individual units, minimizing the number of loading and unloading operations [10, 11, 12].

A positive moment for increasing transportability is the possibility of transporting cars on trailers or on their own.

Versatility, that is, the possibility of multi-purpose use of the excavator, is usually achieved by equipping it with various types of quick-detachable and interchangeable working equipment.

Technical productivity shows the maximum output of the machine for 1 hour of continuous (clean) work and depends on the value of the main technical parameters and the design properties of the machine.

Operational productivity is determined by the fund of machine operation time and characterizes such output, which is achieved under conditions of correct use of machines, when they are serviced by workers of appropriate qualifications.

Operational productivity characterizes the productivity of the machine for 1 hour of the working time of the shift, considering breaks for structural, technical and technological reasons within the working area of the machine [13, 14, 15].

The performance of hydraulic excavators is largely determined by the duration of the working cycle, the main elements of which are filling the bucket (digging), lifting the boom, turning the platform for unloading, unloading and turning back into the face with lowering the working equipment [16].

The total cycle time can be expressed by the formula

$$t_{ц} = t_{к} + t_{пс} + t_{пв} + t_{в} + t_{пз} \qquad (3.1)$$

where $t_{к}$ – dig time;

$t_{пс}$ – boom lifting time;

$t_{пв}$ – unloading turnaround time;

$t_{в}$ – unloading time;

$t_{пз}$ – downhole turning time.

In order to simplify the formula for determining the cycle time and taking into account that part of the operations associated with unloading can be combined with turning to unloading and back to the face,

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the total duration of a double turn with unloading can be coarsely taken equal to 2.5 $_{tp}$, where tp is the turn time for unloading or slaughter.

Then the total cycle time can be expressed as follows:

$t_ц = t_к + t_{пс} + 2{,}5t_п$ (3.2)

Formula (3.2) can be used to determine the cycle time when working in the dump.

When working with single-bucket excavators with vehicles (in particular, during loading), the duration of the working cycle increases due to the additional time spent on centering the excavator bucket and lifting it above the transport. If these time costs are considered by the coefficient k_{mp}, then the formula for determining the cycle time will take the form

$t_ц = k_к (t_к + t_{пс} + 2{,}5t_п)$. (3.3)

Based on the cycle time, the hourly technical productivity of hydraulic excavators is determined:

$$q_{тч} = \frac{3600 \cdot q \cdot k_н}{t_ц \cdot k_p}, \quad (3.4)$$

where q – bucket geometric capacity for excavation of soil of a certain group, m^3;

$k_н$ – bucket filling ratio;

$t_ц$ – duration of the working cycle, sec;

$k_р$ – soil loosening factor.

The bucket filling coefficient characterizes the ease of filling the bucket and the amount of soil loaded into the bucket, and the soil loosening coefficient characterizes the increase in soil volume during development compared to the initial state of natural density.

Hourly operational productivity considers regulated interruptions in the operation of the machine for technical and technological reasons using the coefficient of transition $k_{тэ}$ from technical productivity to operational productivity and is determined by the formula

$q_{эч} = k_{тэ}\, q_{тч}$. (3.5)

The coefficient of transition from technical to operational productivity takes into account breaks only for structural, technical and technological reasons within the working area of the machine and does not take into account any downtime for meteorological and organizational reasons.

Structural and technical reasons, depending on the design of the machine and related to ensuring technical readiness for operation, include maintenance, as well as scheduled repairs, replacement of working equipment and equipment.

Technological breaks include the movement of machines within the working area without performing their main functions and without issuing products for a specified period of time.

Annual operating productivity is determined by the formula

$Q = q_{эч}\, T_г\, k_в$.

where $T_г$ — annual fund of machine time, hour;

$k_в$ — intra-shift time utilization rate.

The intra-shift time utilization factor considers intra-shift time losses due to organizational reasons and weather conditions that are not considered in operational productivity.

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Breaks for organizational reasons include organizational and technological breaks (lack of a work front, insufficient number of component machines, vehicles, etc.), untimely supply of spare parts, fuel, stopping of machines due to poor-quality maintenance and repair, and etc.

Breaks in the operation of machines should be considered to an appropriate extent in the modes of their use. These modes establish the distribution of the operating time of machines in a calendar period as follows;

- performance of basic functions and issuance of products;
- performance of auxiliary functions (movement along the work front within the zone, from one working zone to another or from object to object);
- preparing the machine for work at the beginning or at the end of the shift;
- breaks and downtime in work for one reason or another.

Conclusion

On the basis of the developed modes, the degree of use of machines in time is revealed, measures are planned to improve their use, and the productivity of machines and sets of machines is calculated.

Reliability ratings measure the ability of a machine to perform all functions to specifications under normal use and maintain all original performance for a known or specified period of time.

Reliability is determined by a combination of such properties as non-failure operation, durability, maintainability and storability.

Reliability is the property of a machine to continuously maintain operability in certain modes and operating conditions without forced interruptions.

For repairable products, such as excavators, the reliability indicators can be the time to failure, the probability of failure-free operation.

MTBF is the average of the time between failures of a repairable item. If the operating time is expressed in units of time, then the indicator "mean time to failure" is used to evaluate it.

The probability of failure-free operation is understood as the probability that, in a given time interval or within a given operating time, a product failure does not occur.

Durability is the property of a machine for a long time, with possible interruptions for maintenance and current repairs, to maintain operability in certain modes and operating conditions up to the limit of wear, at which operation is technically impossible, and restoration (repair) is not economically feasible.

Longevity indicators include resource and service life.

The resource means the operating time of the product to the limit state specified in the technical documentation. A distinction is made between a resource before the first overhaul, an overhaul resource, an assigned resource, an average resource, etc. In this case, the assigned resource characterizes the operating time of the product, upon reaching which the operation must be terminated regardless of the state of the product. It is assigned in the technical documentation for reasons of safety and economy and varies by hours (years) of machine operation or the amount of work performed.

Service life - the calendar duration of operation of the product until the occurrence of the limiting state specified in the technical documentation, or until decommissioning.

There is service life to the first overhaul, service life between major repairs, service life to decommissioning, average service life, etc. The meter of this indicator is the hours of operation of the machine, less often the amount of work in physical units.

Maintainability is the property of a machine to restore its working capacity due to the prevention, detection and elimination of failures through maintenance and repairs.

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